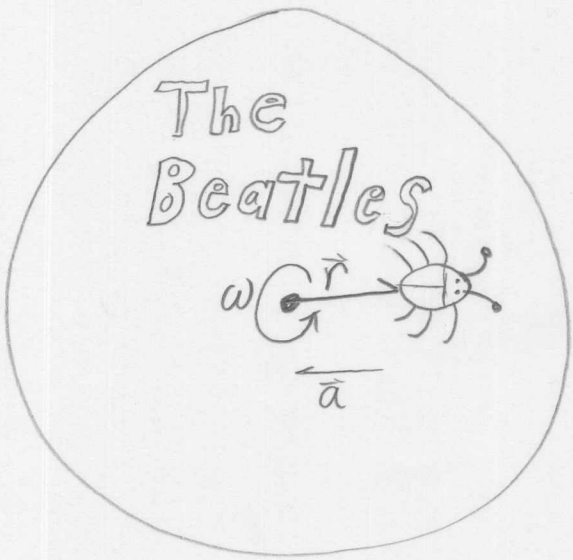
Phys 111
Homework

5-47




Given

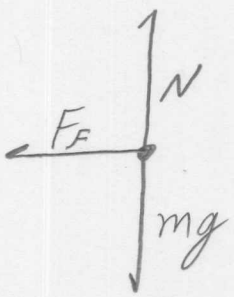
$\tau = 200 \text{ rev/min}$

$\mu_s = 1.2$

$a_c = r\omega^2 = \frac{v^2}{r}$

Want: $r_{max}$

FBD




NSL

$x: -F_F = -ma_c$ ← uniform circular motion

$$+\mu_s N = +mr\omega^2 \quad (1)$$

$y: N - mg = 0$

$$N = mg \quad (2)$$

Combine (1) and (2)

$$\mu_s mg = mr\omega^2 \Rightarrow r_{max} = \frac{\mu_s g}{\omega^2}$$

continued ↓

5-47 continued

Now, $\omega$ has units of $s^{-1}$, which is really $^{rad}/_{s}$.

The problem statement provides $^{rev}/_{min}$ so we have to convert.

We know that $1\,rev = 2\pi\,rad.$ and $1\,min = 60\,s$

So, using unit analysis:

$$\tau\left(\frac{rev}{min}\right)\cdot\frac{1}{60}\left(\frac{min}{s}\right)\cdot 2\pi\left(\frac{rad}{rev}\right) = \omega\left(\frac{rad}{s}\right)$$

$$\Rightarrow \boxed{\omega = \frac{2\pi\tau}{60}}$$

So: $$\boxed{r_{max} = \mu_s g \frac{60^2}{(2\pi)^2\cdot\tau^2}} \;*$$

$$r_{max} = (1.2)(9.8)\frac{60^2}{4\pi^2\,200^2} = 0.027\,m$$

$$= \boxed{2.7\,cm}$$